

**IN THE UNITED STATES PATENT AND TRADEMARK OFFICE**  
**BEFORE THE BOARD OF PATENT APPEALS AND**  
**INTERFERENCES**

Applicant:	Hong-Jyh Li et al.	Examiner:	Quoc Dinh Hoang
Serial No.:	10/799,910	Group Art Unit:	2818
Filed:	March 12, 2004	Docket No.:	2004P50029US/I331.135.101
<b>Due Date:</b>	<b>AUGUST 27, 2007</b>		
Title:	ION IMPLANTATION OF HIGH-K MATERIALS IN SEMICONDUCTOR DEVICES		

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**APPEAL BRIEF UNDER 37 C.F.R. § 41.37**

**Mail Stop Appeal Brief – Patents**

Commissioner for Patents  
P.O. Box 1450  
Alexandria, VA 22313-1450

Dear Sir/Madam:

This Appeal Brief is submitted in support of the Notice of Appeal filed on June 27, 2007, appealing the final rejection of claims 1-5, 7-15, and 17 of the above-identified application as set forth in the Final Office Action mailed March 27, 2007.

The U.S. Patent and Trademark Office is hereby authorized to charge Deposit Account No. 50-0471 in the amount of \$500.00 for filing a Brief in Support of an Appeal as set forth under 37 C.F.R. § 41.20(b)(2). At any time during the pendency of this application, please charge any required fees or credit any overpayment to Deposit Account No. 50-0471.

Appellants respectfully request consideration and reversal of the Examiner's rejection of pending claims 1-15, 7-15, and 17.

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**REAL PARTY IN INTEREST**

The intellectual property embodied in the pending application is assigned to Infineon Technologies North America Corp.

**RELATED APPEALS AND INTERFERENCES**

There are no other appeals or interferences known to Appellants that will have a bearing on the Board's decision in the present Appeal.

**STATUS OF CLAIMS**

In a Final Office Action mailed March 27, 2007, claims 1-5, 7-15, and 17 were finally rejected. Claims 1-5, 7-15, and 17 are pending in the application. Claims 1-5, 7-15, and 17 are the subject of the present Appeal.

**STATUS OF AMENDMENTS**

No amendments have been entered subsequent to the Final Office Action mailed March 27, 2007. A Response was filed on May 25, 2007.

**SUMMARY OF THE CLAIMED SUBJECT MATTER**

The subject matter of the independent claims involved in the Appeal is related to a semiconductor device.

One aspect of the present invention, as claimed in independent claim 1, provides a semiconductor device (40). The semiconductor device (40) includes a substrate (42) including isolation regions (44) and active regions (46, 48, 50). The semiconductor device (40) includes a high-k material layer (56) implanted with a species. The high-k material layer (56) is proximate the substrate (42). The semiconductor device (40) includes a gate electrode (60) proximate the high-k material layer (56) and a conductive buffer layer (58) implanted with a species between the high-k material layer (56) and the gate electrode (60). *See Specification*, at page 4, line 2 through page 6, line 3; and Figure 1.

Another aspect of the present invention, as claimed in independent claim 15, provides a transistor (40). The transistor (40) includes a gate electrode (60) and a high-k gate dielectric layer (56) implanted with a species. The high-k gate dielectric layer (56) is

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proximate the gate electrode (60). The transistor (40) includes a substrate (42) including an active region (46, 48, 50). The substrate (42) is proximate the high-k gate dielectric layer (56). The transistor (40) includes a conductive buffer layer (58) implanted with a species between the gate electrode (60) and the high-k gate dielectric layer (56). *See Specification*, at page 4, line 2 through page 6, line 3; and Figure 1.

GROUND'S OF REJECTION TO BE REVIEWED ON APPEAL

- I. Whether claims 1-5, 7, 9, 10, 14, 15, and 17 are patentable under 35 U.S.C. § 102(b) over Rodder et al., U.S. Patent No. 6,251,761 ("Rodder") and whether claims 8 and 11-13 are patentable under 35 U.S.C. § 103(a) over Rodder.

ARGUMENT

**I. The Applicable Law**

With regard to a 35 U.S.C. § 102(b) anticipation rejection: "A person shall be entitled to a patent unless- (b) the invention was patented or described in a printed publication in this or a foreign country or in public use or on sale in this country, more than one year prior to the date of the application for patent in the United States." 35 U.S.C. § 102(b).

A rejection based on 35 U.S.C. § 102(b) can be overcome by: persuasively arguing that the claims are patentably distinguishable from the prior art; or, amending the claims to patentably distinguish over the prior art. M.P.E.P. § 706.02(b).

**II. Rejection of claims 1-5, 7, 9, 10, 14, 15, and 17 under 35 U.S.C. § 102(b) as being unpatentable over Rodder et al., U.S. Patent No. 6,251,761 ("Rodder") and rejection of claims 8 and 11-13 under 35 U.S.C. § 103(a) as being unpatentable over Rodder.**

Independent claims 1 and 15 are patentably distinct from Rodder.

Appellants submit that Rodder fails to teach or suggest the limitations recited by independent claim 1 including a **high-k material layer implanted with a species; and a conductive buffer layer implanted with a species between the high-k material layer and the gate electrode.**

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Rodder discloses a gate stack 104 including a high-k dielectric 108 formed over a silicon substrate 102. Remote plasma nitridation of the high-k dielectric is performed to create a nitride layer 107 over the high-k dielectric. Conductive layer 110 is formed over the nitride layer 107 forming the gate electrode. (Abstract). Silicon dioxide layer 118 is subjected to remote plasma nitridation (RPN). RPN converts layer 118 from silicon dioxide to silicon-oxy-nitride layer 106. (Col. 3, lines 25-28). After RPN, high-K dielectric layer 108 is formed over silicon oxy-nitride layer 106. (Col. 3, lines 55-56). Following high-K formation, the stack is again subjected to the remote plasma process and a top portion of the high-K dielectric will be converted to a nitride 107. (Col. 4, lines 42-45). Gate electrode material 110 is deposited over the nitride layer 107. (Col. 4, lines 52-53). In another embodiment, gate electrode 110 comprises a layer of tungsten (W) overlying a layer of titanium-nitride (TiN). (Col. 4, lines 59-62).

The Examiner submits that the high-k dielectric layer 108 of Rodder teaches the *high-k material layer implanted with a species* recited by claim 1. High-k dielectric layer 108 of Rodder, however, is not implanted with a species. Rodder teaches that the top portion of the high-k dielectric material is converted to provide nitride 107. The remaining high-k dielectric layer 108 is not implanted with a species.

The Examiner also submits that the gate electrode 110 comprising a metal layer overlying a layer of TiN of Rodder discloses *a conductive buffer layer implanted with a species between the high-k material layer and the gate electrode* recited by claim 1. (Final Office Action, page 2). The layer of TiN of Rodder, however, is not implanted with a species. Both remote plasma processes disclosed in Rodder occur before gate electrode 110 including the layer of TiN is deposited. Therefore, the TiN layer cannot be implanted with a species.

For similar reasons as discussed above with reference to independent claim 1, Rodder fails to teach or suggest the limitations recited by independent claim 15 including **a high-k gate dielectric layer implanted with a species; and a conductive buffer layer implanted with a species between the gate electrode and the high-k gate dielectric layer.**

In view of the above, Appellants respectfully request reversal of the rejection of independent claims 1 and 15 under 35 U.S.C. §102(b). Dependent claims 2-5, 7, 9, 10, 14, and 17 further define patentably distinct independent claim 1 or 15. Accordingly, Appellants

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believe these dependent claims are also allowable over the cited reference. Appellants respectfully request reversal of the rejection of claims 2-5, 7, 9, 10, 14, and 17 under 35 U.S.C. § 102(b).

Dependent claims 8 and 11-13 further define patentably distinct independent claim 1. Accordingly, Appellants believe these dependent claims are also allowable over the cited reference. Appellants respectfully request reversal of the rejection of claims 8 and 11-13 under 35 U.S.C. § 103(a).

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**CONCLUSION**

For the above reasons, Appellants respectfully submit that the cited reference neither anticipates nor renders obvious claims of the pending Application. The pending claims distinguish over the cited reference, and therefore Appellants respectfully submit that the rejections must be withdrawn, and respectfully request the Examiner be reversed and claims 1-5, 7-15, and 17 be allowed.

Any inquiry regarding this Appeal Brief should be directed to Mark A. Peterson at Telephone No. (612) 573-0120, Facsimile No. (612) 573-2005. In addition, all correspondence should continue to be directed to the following address:

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Respectfully submitted,

Hong-Jyh Li, et al.,

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Dated: August 27, 2007  
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**CLAIMS APPENDIX**

1. (Previously Presented) A semiconductor device comprising:  
a substrate including isolation regions and active regions;  
a high-k material layer implanted with a species, the high-k material layer proximate the substrate;  
a gate electrode proximate the high-k material layer; and  
a conductive buffer layer implanted with a species between the high-k material layer and the gate electrode.
2. (Original) The semiconductor device of claim 1, wherein a transistor is formed from the substrate, the high-k material layer, and the gate electrode.
3. (Original) The semiconductor device of claim 1, further comprising:  
a pre-gate material layer between the substrate and the high-k material layer.
4. (Original) The semiconductor device of claim 3, wherein the pre-gate material layer comprises one of SiO<sub>2</sub> and SiON.
5. (Original) The semiconductor device of claim 3, wherein the pre-gate material layer has a thickness within the range of 2Å to 10Å.
6. (Cancelled)
7. (Previously Presented) The semiconductor device of claim 1, wherein the buffer layer comprises one of TiN, HfN, TaN, ZrN, LaN, and TiSi.
8. (Previously Presented) The semiconductor device of claim 1, wherein the buffer layer has a thickness within the range of 10Å to 200Å.
9. (Original) The semiconductor device of claim 1, wherein the species comprises one of N, F, Si, O, Hf, Zr, Ti, Ta, Y, V, Sc, Ba, Sr, Ru, B, Al, Ga, In, Ge, C, P, As, and Sb.



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10. (Original) The semiconductor device of claim 1, wherein the high-k material layer comprises one of  $\text{HfO}_2$ ,  $\text{HfSiO}_x$ ,  $\text{ZrO}_2$ ,  $\text{ZrSiO}_x$ ,  $\text{SiO}_2$ ,  $\text{SiON}$ ,  $\text{Ta}_2\text{O}_5$ ,  $\text{La}_2\text{O}_3$ , and  $\text{Al}_2\text{O}_3$ .
11. (Original) The semiconductor device of claim 1, wherein the high-k material layer has a thickness within the range of 10Å to 60Å.
12. (Original) The semiconductor device of claim 1, wherein the high-k material layer has an equivalent oxide thickness within the range of 3Å to 20Å.
13. (Original) The semiconductor device of claim 1, wherein a dose of the implanted species is within the range of  $1 \times 10^{13}$  ions/cm<sup>2</sup> to  $1 \times 10^{16}$  ions/cm<sup>2</sup>.
14. (Original) The semiconductor device of claim 1, wherein the isolation regions comprise trench isolation regions.
15. (Previously Presented) A transistor comprising:  
a gate electrode;  
a high-k gate dielectric layer implanted with a species, the high-k gate dielectric layer proximate the gate electrode;  
a substrate comprising an active region, the substrate proximate the high-k gate dielectric layer; and  
a conductive buffer layer implanted with a species between the gate electrode and the high-k gate dielectric layer.
16. (Cancelled)
17. (Original) The transistor of claim 15, wherein the gate electrode comprises one of aluminum and polysilicon.
- 18-40. (Cancelled)

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**EVIDENCE APPENDIX**

None.

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**RELATED PROCEEDINGS APPENDIX**

None.